H.E.S.S. observations of the unprecedented gamma-ray outburst of PKS 0903-57

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for the H.E.S.S. Collaboration

GAMMA 2024
Milano, Italy

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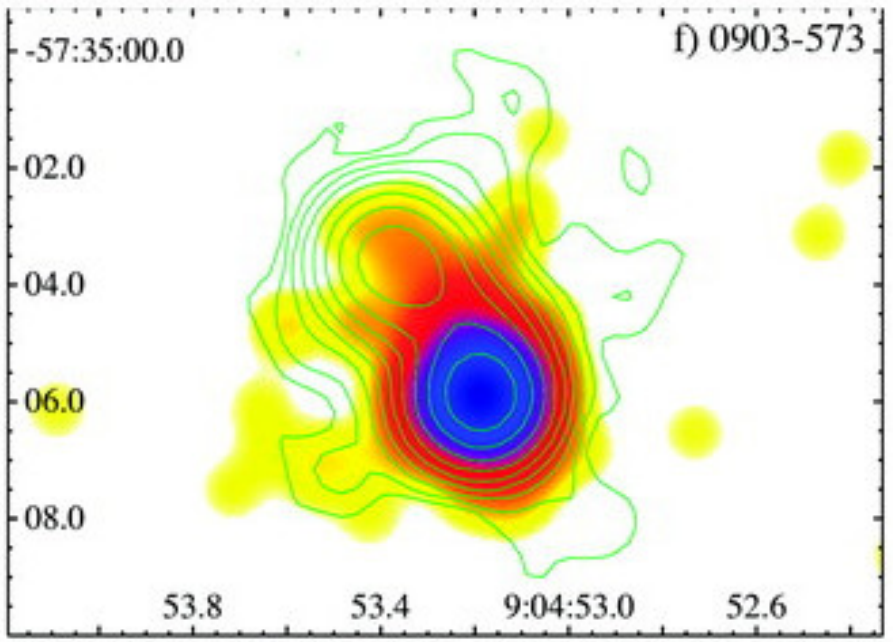
Source overview



X-ray image and radio contours of PKS 0903-57 (Marshall+05)

- PKS 0903-57 is a blazar with strong radio emission and an X-ray jet

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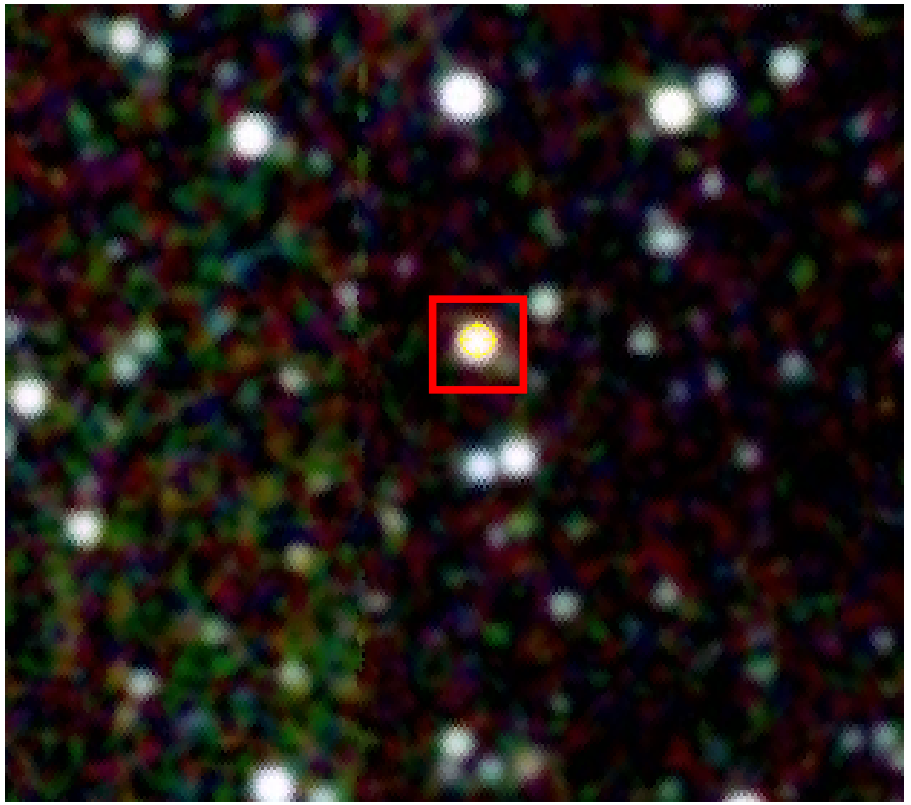

2MASS JHK image (NED)

- PKS 0903-57 is a blazar with strong radio emission and an X-ray jet
- A Galactic star is only 0.7″ away from the radio source position

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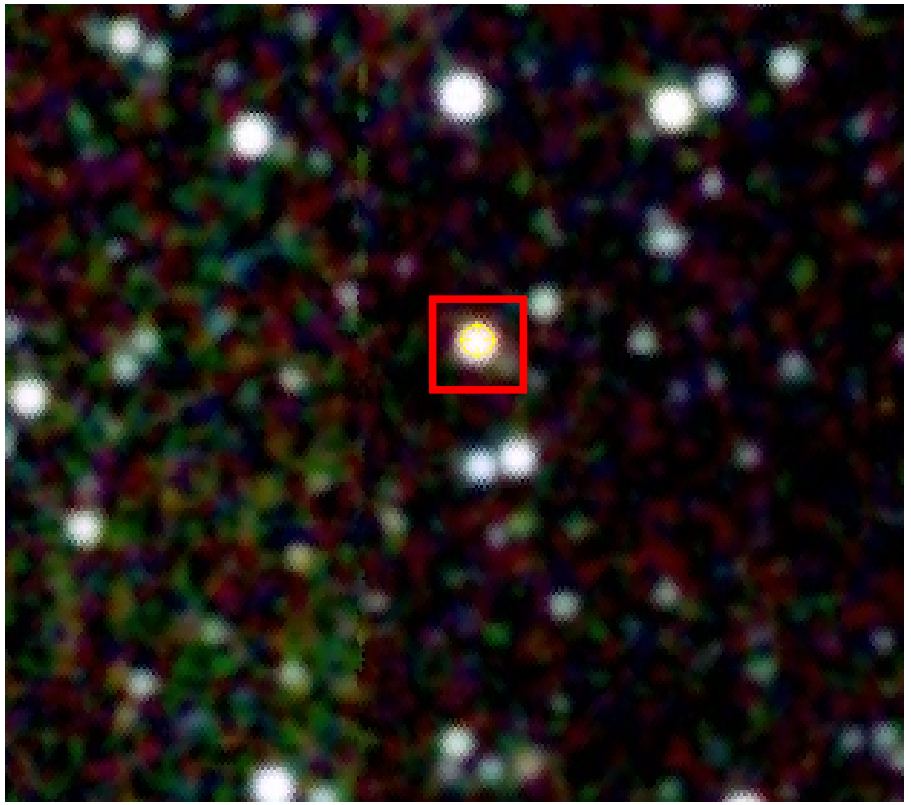
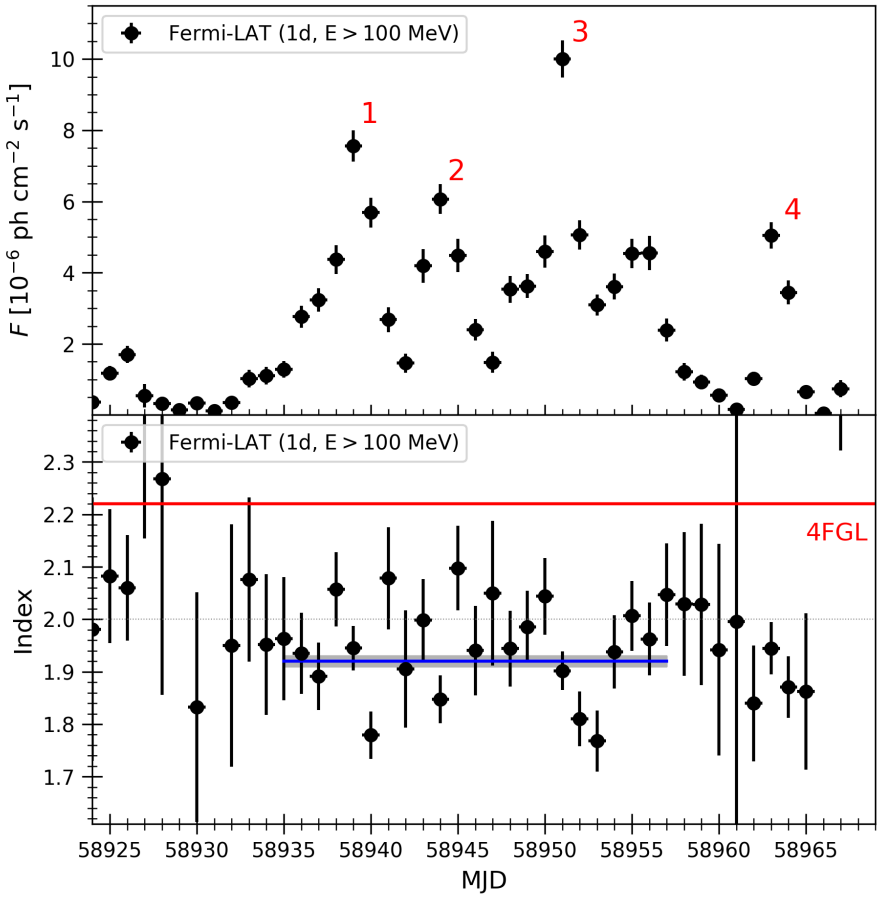


2MASS JHK image (NED)

- PKS 0903-57 is a blazar with strong radio emission and an X-ray jet
- A Galactic star is only $0.7''$ away from the radio source position
- A recent effort by Goldoni et al. (submitted)
  - established a redshift of $z \sim 0.26$
  - classified the source probably as an FSRQ

HE γ-ray flare in 2020



Fermi-LAT light curve (top) and index (bottom) in March/April 2020

- For most of the time during the *Fermi* era, the HE flux has been steady
- In March/April 2020, PKS 0903-57 showed a very bright outburst
- The episode is marked by 4 distinct peaks
  - a plateau around the 3rd peak
  - Peak 4 seems detached

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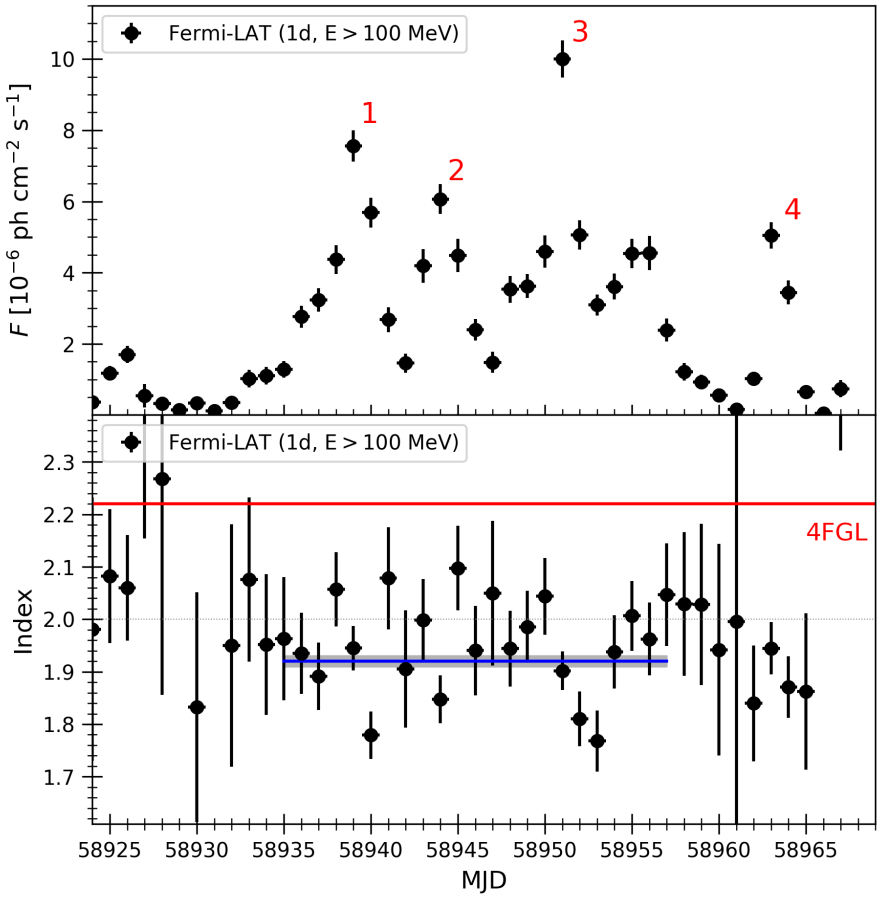

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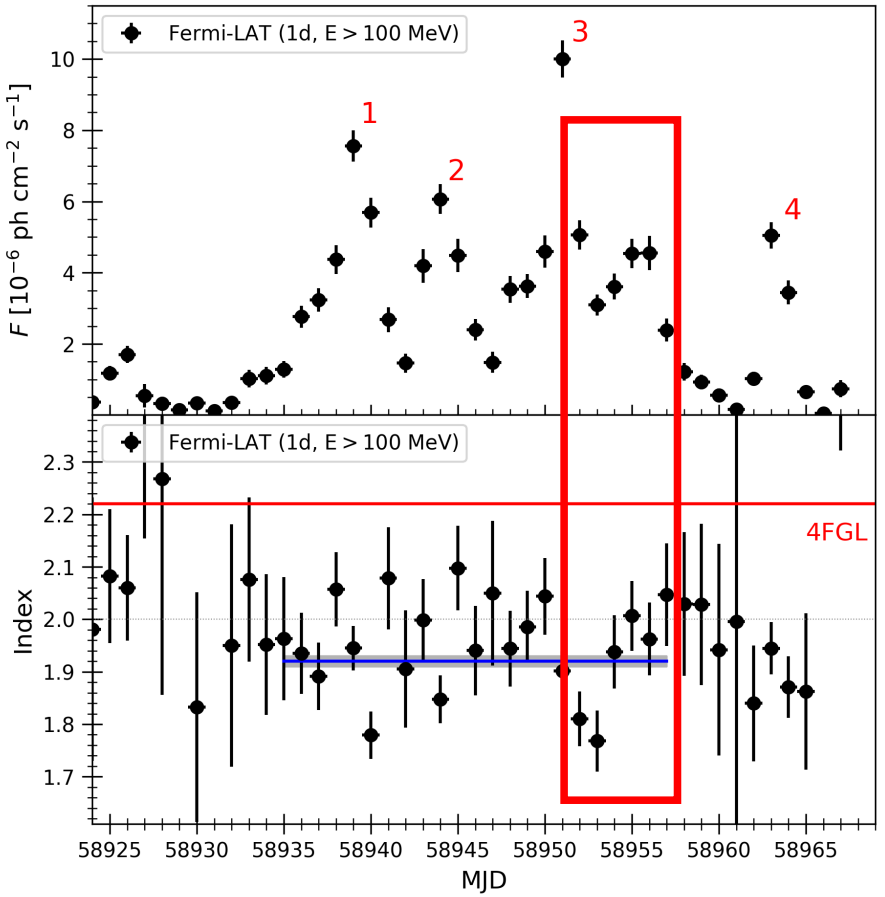
- The episode is marked by 4 distinct peaks
  - a plateau around the 3rd peak
  - Peak 4 seems detached
- Flux variability time scale on the order of a few hours
- The average index in this period is ~ 1.9, which is much harder than the 4FGL average; the index is also significantly variable during the first 3 peaks
- During peaks 1 and 3, the lowest indices came after the flux maxima

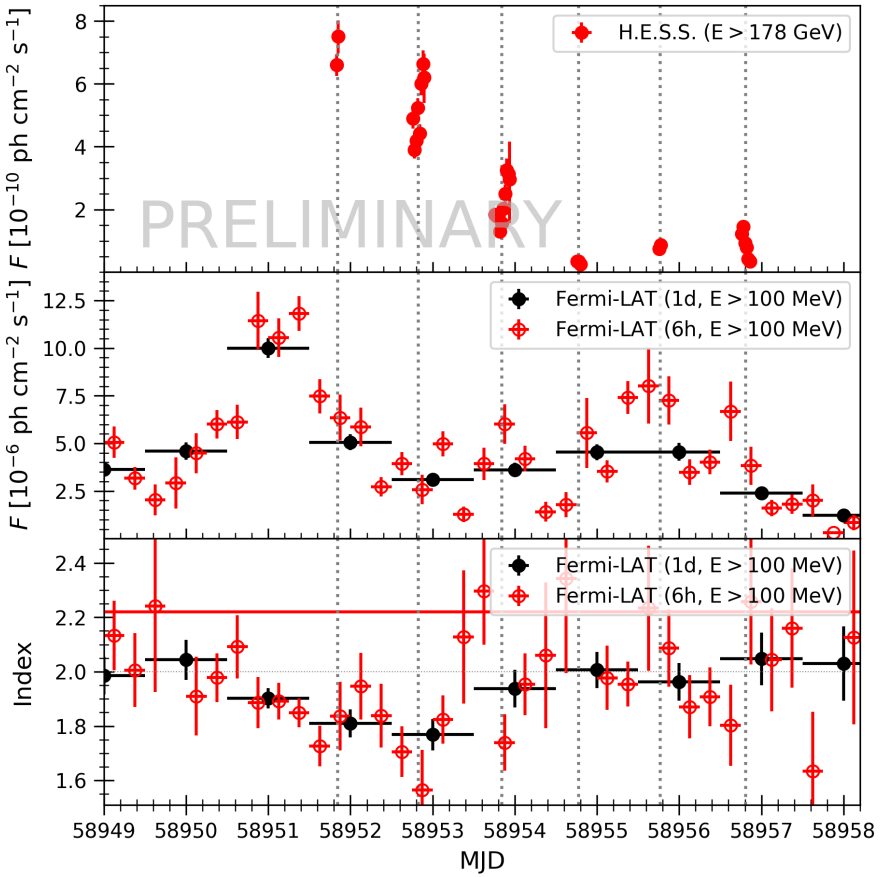
H.E.S.S. observations during the flare



Fermi-LAT light curve (top) and index (bottom) in March/April 2020

- H.E.S.S. was able to follow-up after the 3rd peak
- A total of 13.1 h of data were collected with $\sim 100\sigma$ significance above 160 GeV

H.E.S.S. observations during the flare



H.E.S.S. light curve (top), *Fermi*-LAT light curve (middle) and index (bottom) after the 3rd peak

- H.E.S.S. was able to follow-up after the 3rd peak
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- The VHE flux variability time scale is on the order of a few hours
- The VHE flux evolution differs from the HE flux evolution, but is anti-correlated with the HE index
- This suggests time- and energy-dependent acceleration and cooling processes

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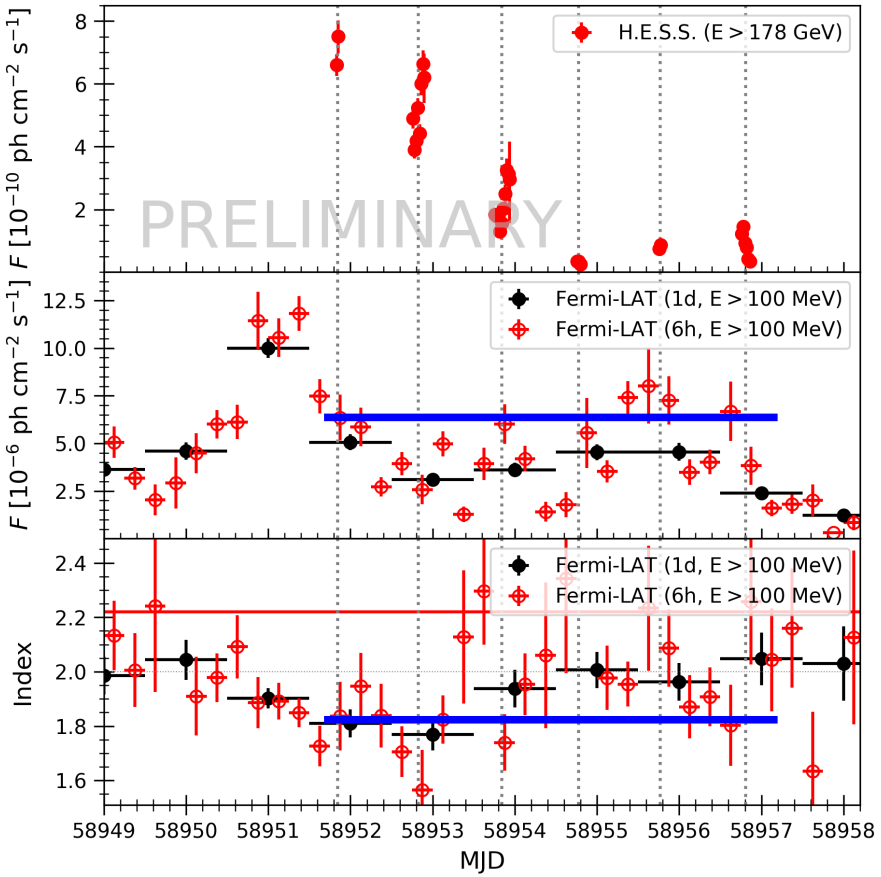

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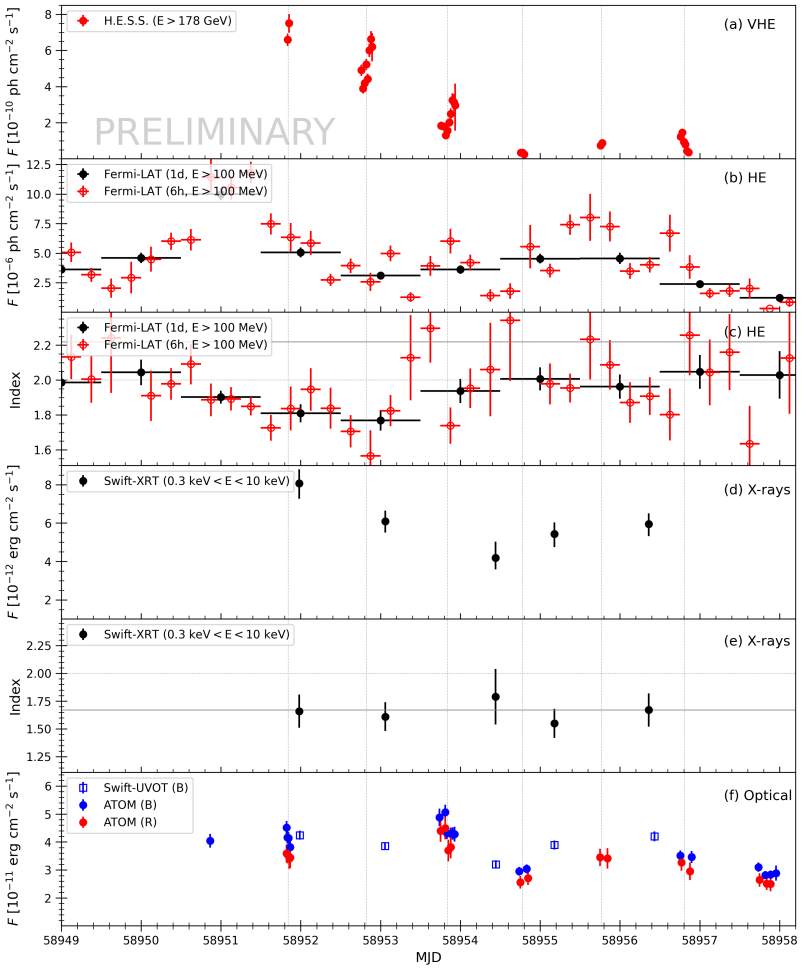
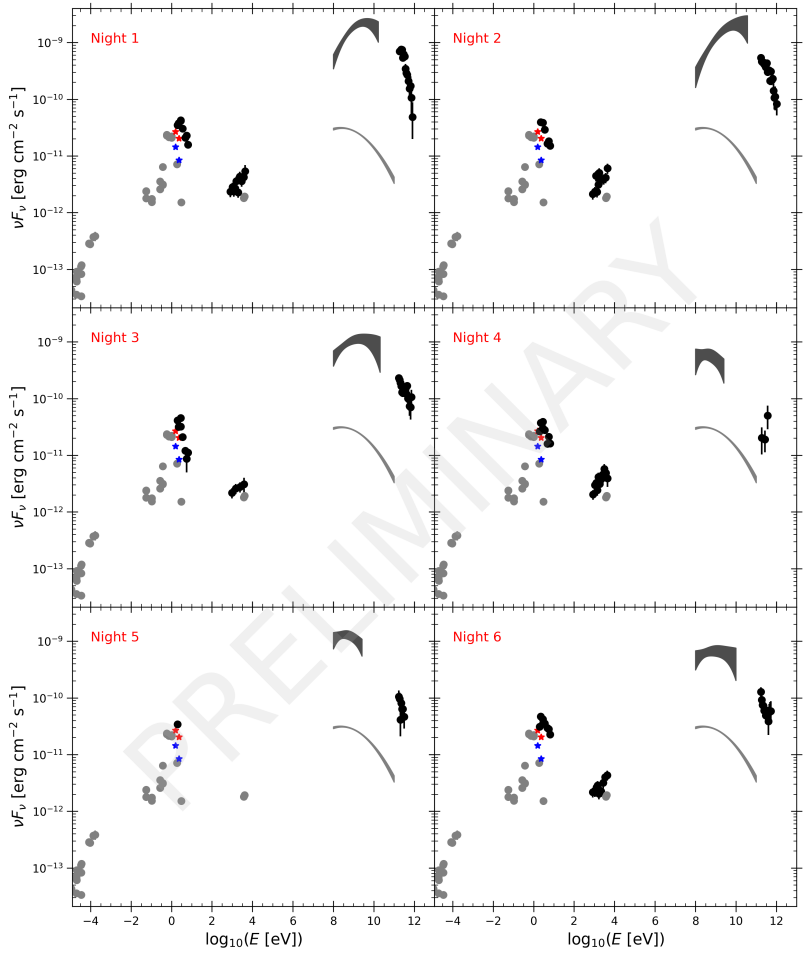
MWL variability around the 3rd peak



MWL light curves as indicated around the 3rd peak

- Additional data from *Swift* and ATOM
- X-ray and optical variability is minor compared to the γ rays
- This resembles other FSRQ flares

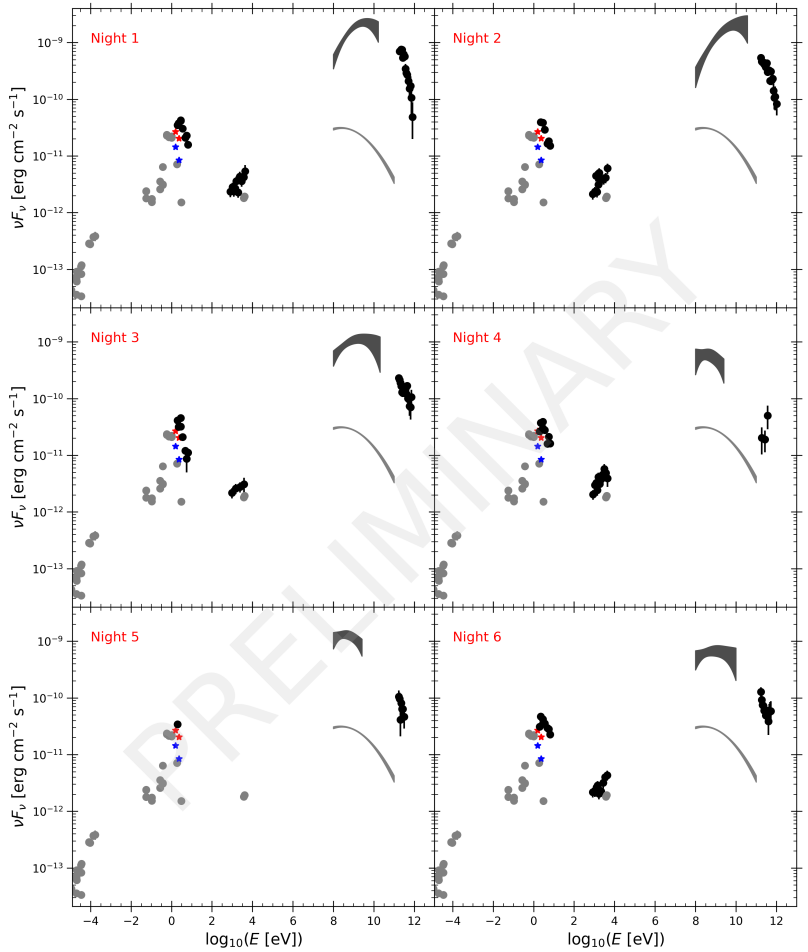
MWL spectrum during the H.E.S.S. observations



MWL spectrum quasi-simultaneous with the H.E.S.S. observations

- The change in the γ-ray spectrum compared to the 4FGL (light gray butterfly) is striking
- γ-ray peak position has increased from $\sim$ 100 MeV (4FGL) to several GeV
- Minor changes only in the X-ray spectrum
- Optical spectrum influenced by *the star*
  - Difficulty to constrain the synchrotron component

Constraints



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  - Maximum distance from black hole: $d \lesssim 1$ pc (assuming filling widths of jet)

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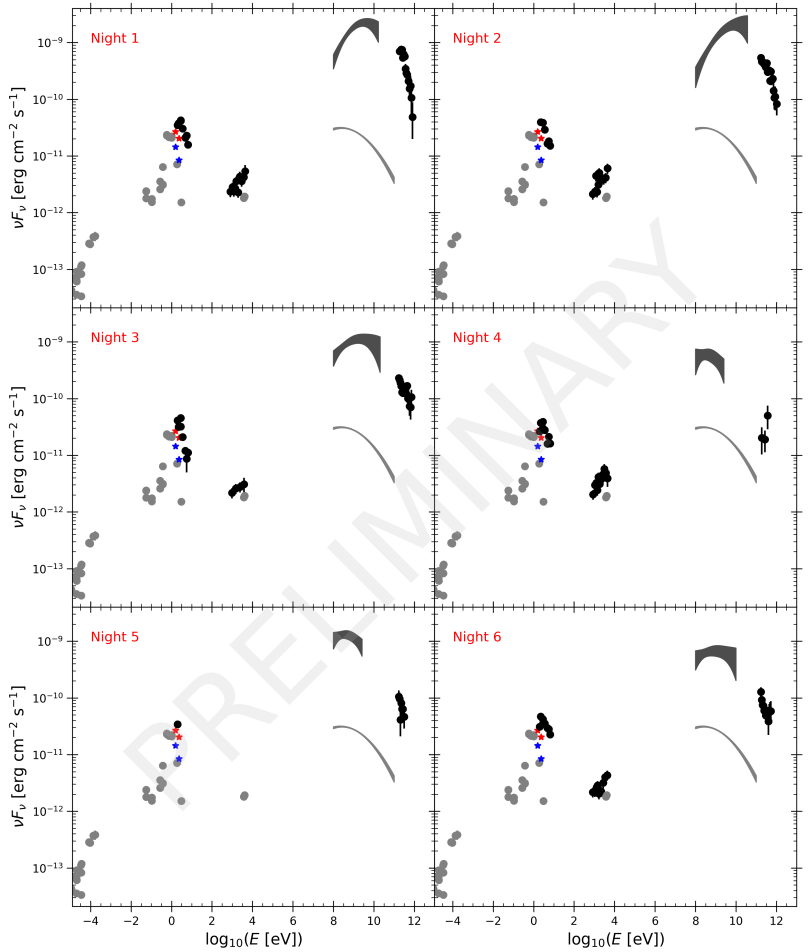

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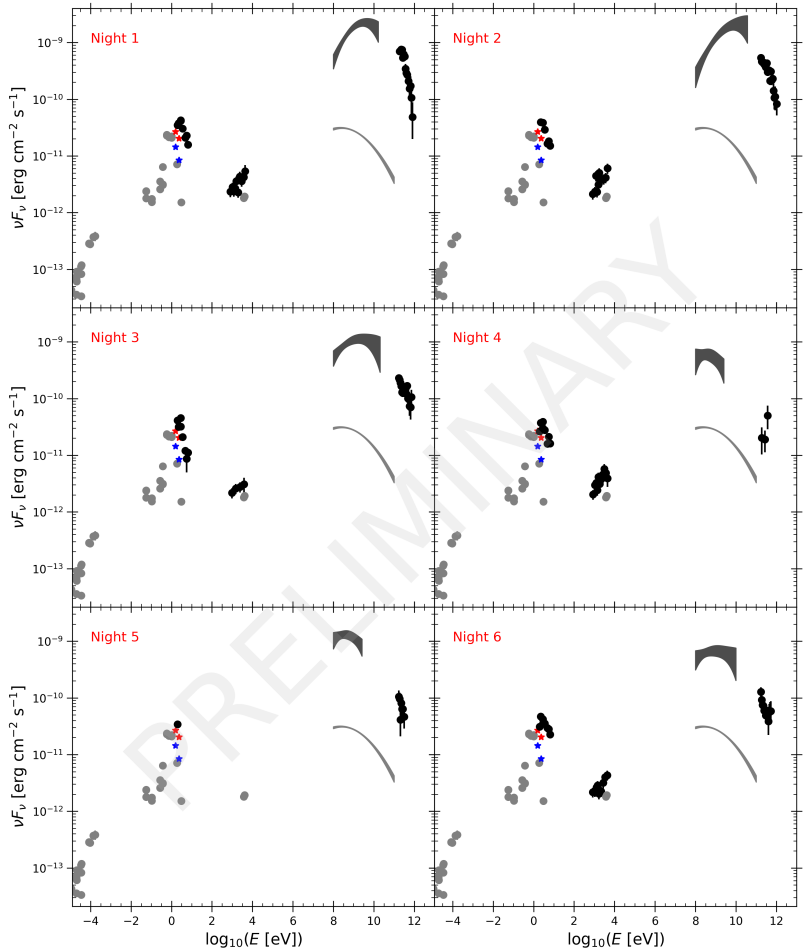

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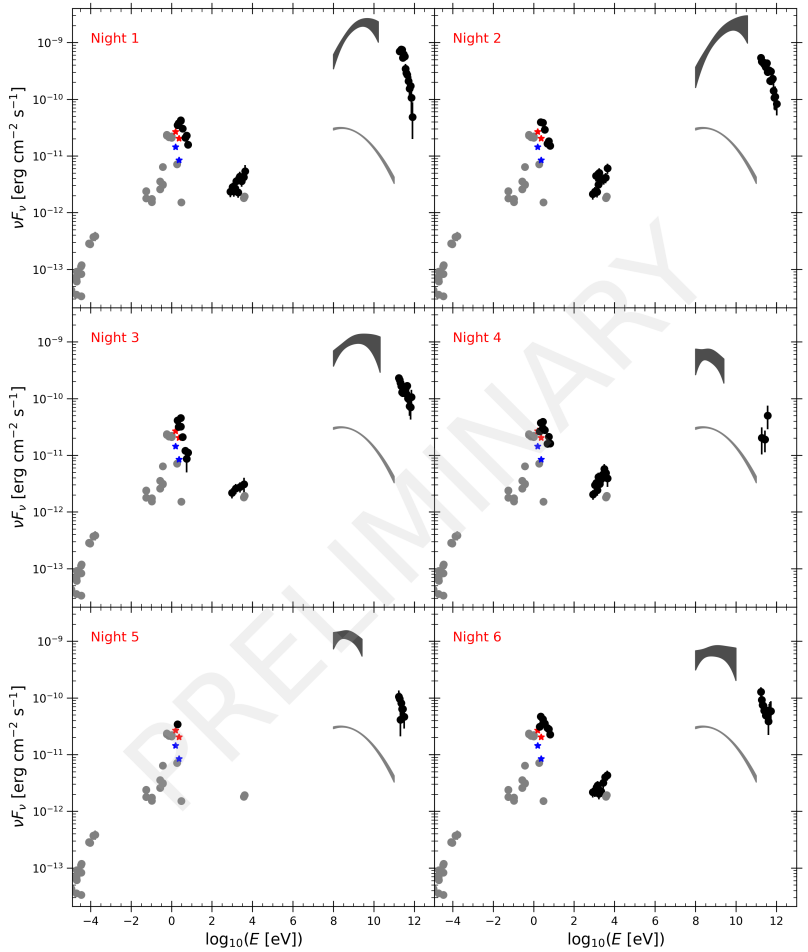

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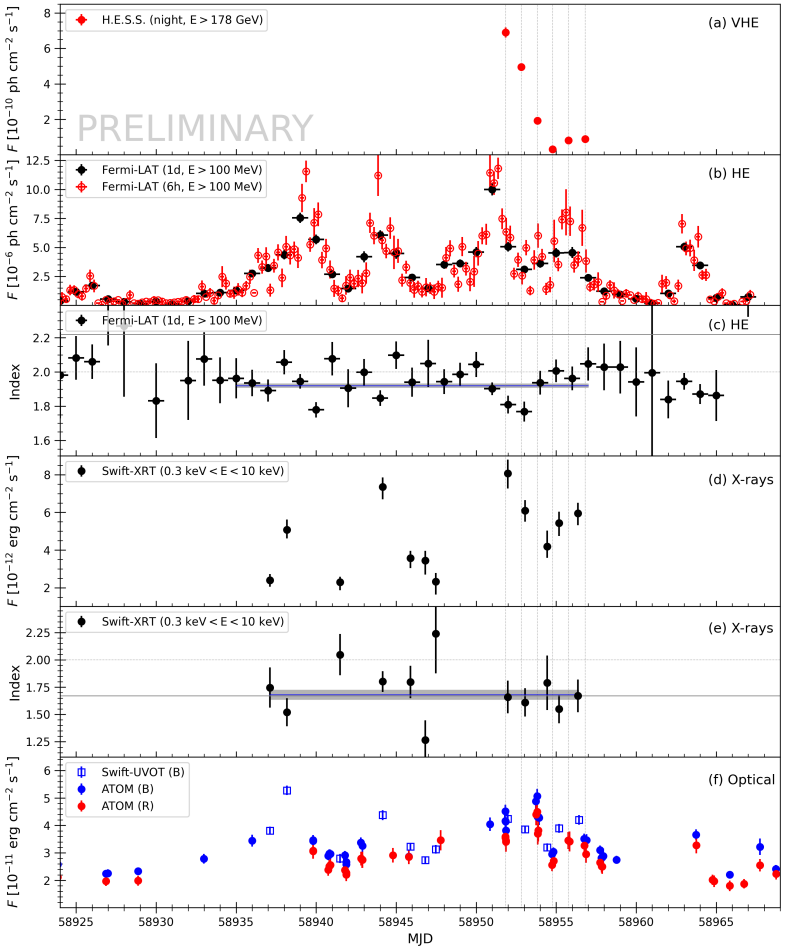
- VHE spectrum up to TeV domain suggests the emission region is beyond the BLR within the DT
  - Implies low magnetic fields and a particle-dominated emission region
- Constraints suggestive of an emission region located within the DT
- The low magnetization suggests acceleration at a shock

Summary: The pandemic flare of PKS 0903-57



MWL light curves during the flare of PKS 0903-57 in March/April 2020

- Massive MWL flare in PKS 0903-57 in 2020
- VHE γ-ray detection after the 3rd peak with interesting (non-)correlations with the HE γ rays
- Strong flux and spectral variability
- The MWL constraints suggest that the flare probably
  - took place within the DT
  - was powered by shock acceleration

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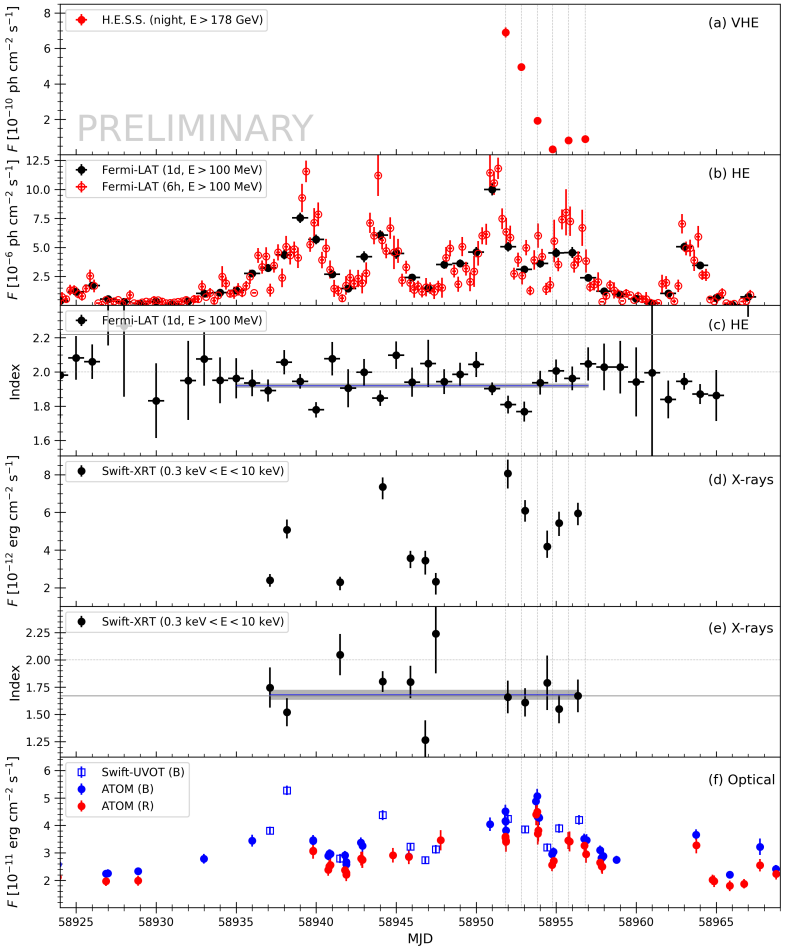

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